Botanical Studies of Natural and Manipulated Terrain Units on the Fosheim Peninsula, Northern Ellesmere Island, Northwest Territories

J.D. Lambert

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BOTANICAL STUDIES OF NATURAL AND MANIPULATED TERRAIN UNITS ON THE FOSHEIM PENINSULA, NORTHERN ELLESMERE ISLAND, NORTHWEST TERRITORIES

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This report was prepared under contract for the Arctic Land Use Research Program, Northern Natural Resources and Environment Branch, Department of Indian Affairs and Northern Development. The views, conclusions and recommendations expressed herein are those of the author and not necessarily those of the Department.

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Table of Contents

Page

LIST OF FIGURES ii

LIST OF TABLES iii

ABSTRACT iv

1. INTRODUCTION 1

2. LITERATURE REVIEW 2

3. STUDY AREA 3

4 METHODS 8

5 PRELIMINARY ANALYSIS AND RESULTS 9

Vegetation and Soils 9
Soil Moisture 16
Depth of Thaw 19

6 SUMMARY 28

7 RECOMMENDATIONS 28

8 REFERENCES 29

Appendix I Soil Profile Description 30

Appendix II Vegetation maps of removed plots terrain units 31

LIST OF FIGURES

Figure		Page
1	Field study location, Fosheim Peninsula, Northern Ellesmere Island, Northwest Territories	4
2	Percent available soil moisture in all study plots between July 23 and August 13/1973.	5
3	Mean depth of thaw (cm) levels for all plots in the Salix-polygon and Dryas-hummock terrain units between July 1 and August 12/1973.	6
4	Mean depth of thaw (cm) levels for all plots in the Low-centered polygon and Sedge-hummock terrain units between July 1 and August 12/1973.	7
5	Mean depth of thaw (cm) levels for all control and chopped plots between July 1 and August 12/1973.	8
6	Mean depth of thaw (cm) levels for all removed plots between July 1 and August 12/1973.	18
7	Mean depth of thaw (cm) levels for all plots in the Salix-polygon and Dryas-hummock terrain units between July 1 and August 12/1973.	23
8	Mean depth of thaw (cm) levels for all plots between July 1 and August 12/1973	24
9	Mean depth of thaw (cm) levels for all control and chopped plots between July 1 and August 12/1973.	26
10	Mean depth of thaw (cm) levels for all removed plots between July 1 and August 12/1973.	27

LIST OF TABLES

Table — Page

I Average percent frequency and cover of plant species in the *Salix*-polygon terrain unit 10

II Average percent frequency and cover of plant species in the *Dryas*-hummock terrain unit 13

III Average percent frequency and cover of plant species in the Low-centered polygon terrain unit 15

IV Average percent frequency and cover of plant species in the Sedge-hummock terrain unit 15

V Percent available moisture in soils sampled in control and manipulated plots 17

VI Plot studies - Depth of Thaw (cm) 20

APPENDIX I

1. Description of soil profiles 30

APPENDIX II

Vegetation maps of removed plots in all four terrain units 31

Abstract

Botanical studies were conducted in control and manipulated (chopped and removed) plots in *Salix* - polygon,*Dryas* - hummock,Low-centered and Sedge - hummock terrain types on the Fosheim Peninsula,Northern Ellesmere Island, Northwest Territories during the summer of 1973. Quantitative data were collected on species frequency and cover. Changes in soil moisture were determined in all plots. In the control and chopped plots within each terrain type soil moisture curves were similar. In the removed plots values for the *Salix* - polygon and *Dryas* - hummock indicate a low soil moisture content in the upper portion of the permafrost.

In the *Salix* - polygon and *Dryas* - hummock mean depth of thaw rates in control,chopped and removed plots suggest that disturbance to the insulative layer does not effect rate of thaw. In the wet sites (Low-centered polygon and Sedge - hummock) mean rates of thaw in the control and chopped plots followed a similar pattern as in the dry sites. In the removed plots between July 15 and 22 a rapid thaw occurred - possibly indicative of a layer of buried ice.

If the movement of vehicles is to be approved on the Fosheim Peninsula during the summer it is recommended that vehicles be prohibited from meadows and creeks.

Introduction

During the last decade there has been a considerable amount of concern over the effects of the passage of tracked vehicles over the tundra. Until 1971 studies relating to these effects (removal of vegetation, thermokarst, thermal erosion etc) had been concentrated in the Mackenzie Delta region and to a limited extent on Banks Island. The rapid increase in exploration activities in the Arctic Islands has resulted in severe scarring of the land surface on parts of Melville Island, Ellef Ringnes Island and Northern Ellesmere Island. What effect such disturbance will have in the future on the stability of the land surface is not known. To determine the effects of disturbance to tundra ecosystems in a high Arctic environment studies were initiated in 1973 on the Fosheim Peninsula, Northern Ellesmere Island. The Fosheim Peninsula was selected because Panarctic were actively drilling in the vicinity and had constructed winter roads to move drilling equipment.

Under the terms of reference the contract required that in co-operation with Dr. M.W. Smith investigations would be carried out to:

1. assess the short and long term effects of disturbances to tundra ecosystems with respect to areas of sensitivity, tolerance of different plant communities to disturbance, and rate of type of sequence of vegetation recovery by quantitative and qualitativ observations of changes in vegetation and near surface soil layers that accompany modifications to the surface condition of the terrain.
2. make a preliminary evaluation of a terrain sensitivity classification system.
3. aid in the development of guidelines for the implementation of the Territorial Land Use Regulations with respect to various types

of land use operation in a high Arctic environment.

A major component of the study was a detailed analysis of the microclimate by Dr. Smith. A report of this particular aspect of the tundra disturbances can be obtained from Dr. Smith's report.

This report covers the results of the botanical and soil active layer research undertaken during the summer of 1973 as part of the Arctic Land Use Research (ALUR) program of the Department of Indian and Northern Affairs.

LITERATURE REVIEW

A number of studies to determine the affects of vehicle traffic on the land surface in the High Arctic have been initiated over the last five years. However, to date only two have published results.

Kevan (1971) concluded that tracked vehicles in use at Lake Hazen, Northern Ellesmere Island, had not started serious thermokarst or chronic erosion although well-drained and well walked areas had suffered alike from denudation of vegetation. Greatest environmental damage had occurred when drainage patterns had been altered, especially when leading to drainage of marshy areas. Any driving was bound to remove some vegetation through soil shearing by vehicle grousers or cross-links. Track marks made in 1957 are still visible.

Babb (1972) in studies at Cape Sparbo, Devon Island, and from observations on other islands concluded that the movement of vehicles on High Arctic terrain could reduce plant cover by 50-100%. In polar desert areas overall effect was small. However, in protected areas (creek meadows) where cover approached 100%, disturbance had effects similar to those in the Low Arctic. On Devon Island where vegetation and soil were removed active layer thickness increased by 10-15%; reflected short wave solar radiation was halved, but soil heat flux altered relatively little.

Surface disturbance of High Arctic soils can lead to increases in thickness of up to 50%. Smallest increases occurred on dry well drained ridges while greatest increases were in low lying poorly drained meadows. Reinvasion of disturbed areas was relatively slow. Efficient seed or bulbil producers were the most rapid invaders on mesic and dry sites. In meadow sites invasion of higher plant was primarily lateral encroachment by rhizomes.

A report by Kerfoot and Lambert (1971) on the effects of winter seismic operations on Banks Island concluded that minimal damage to the vegetation had occurred. Supply roads and seismic lines were for the most part difficult to locate. No quantitative data were collected.

STUDY AREA

The study area lies approximately three miles NNE of Eastwind Lake, at 80^{o} 8'N and 85^{o} 31'W, close to the base of Blacktop Ridge (Figure 1). A gravel ridge, running NW - SE, separates the study site from the main camp that is situated on the north side of a small lake. The study area was not located at Eastwind Lake where previous vegetation studies had been conducted (Inglis and Jonkel, 1972) because of the effect such a large body of water could have on the surrounding terrestrial microclimate.

Inglis and Jonkel (1972) have described the terrain units, and their development, and plant communities in the vicinity of Eastwind Lake. Specifically the study area lies between a braided stream on the east side and gravel knoll on the west. The area slopes gradually to the northwest. To the south are numerous closed ponds of varying size and shape that are probably thermokarst in origin. Two terrain units on a better drained section of the study area are evident. Small (60-150 cm diameter), flat, high-centered polygons with exposed mineral soil are most prominent. Ice wedges are narrow (5-10 cm wide) and relatively shallow (20-30 cm deep).

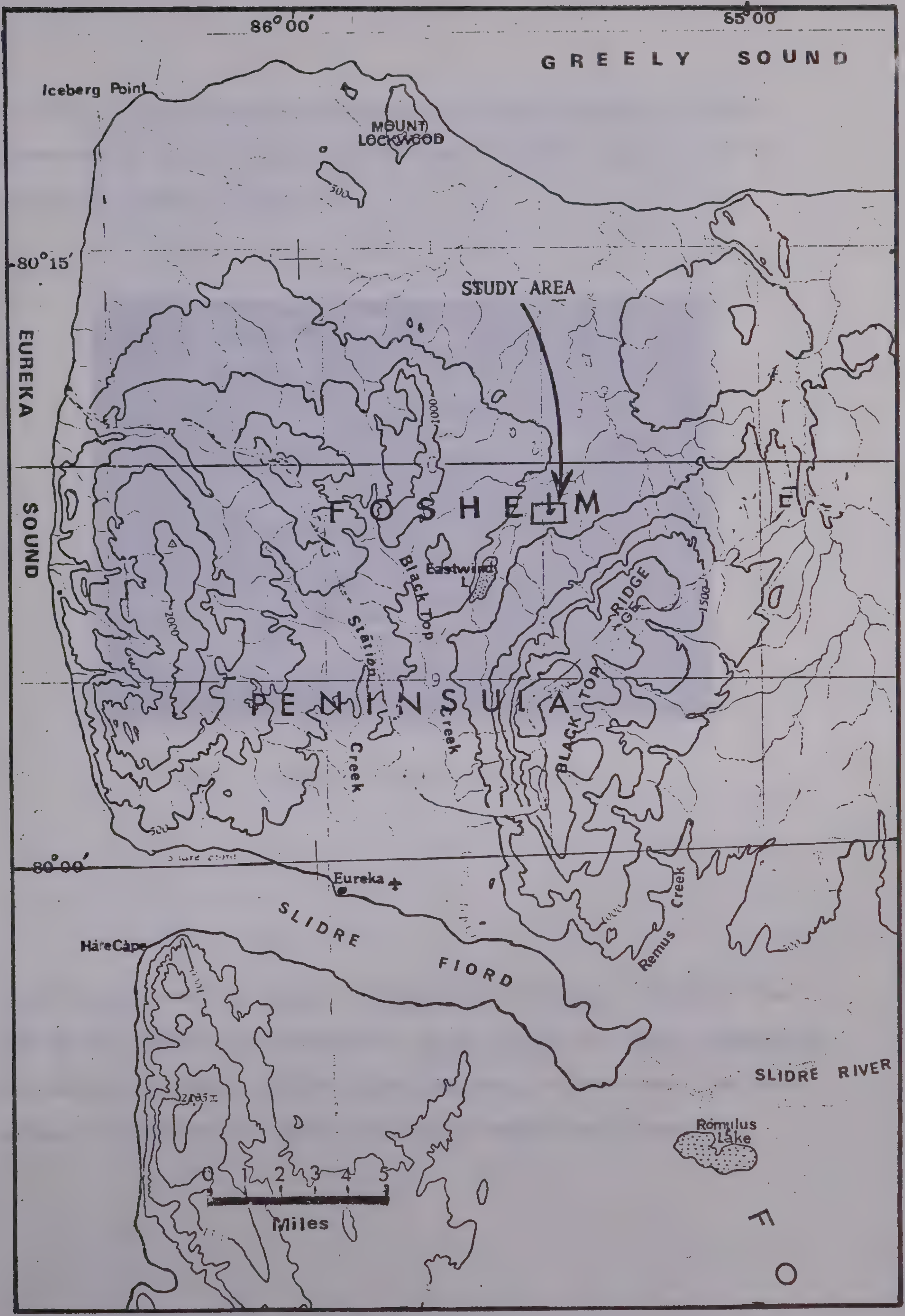

Figure 1. Field study location, Fosheim Peninsula, Northern Ellesmere Island, N.W.T.

The sides of the polygons are vegetated by vascular plants and mosses. Lichens are of minimal importance, are mainly crustose and occur on the tops of the polygons (Figure 2).

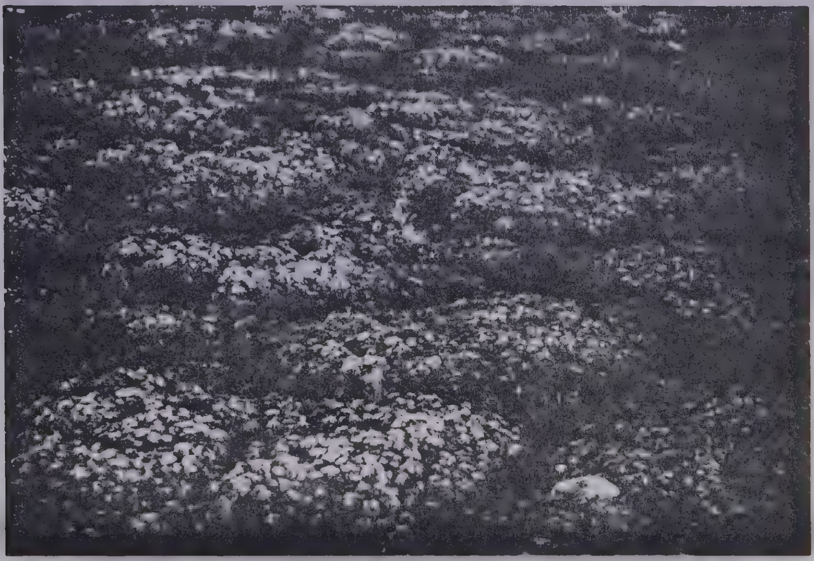

Figure 2. Salix - polygon terrain unit.

Frost hummocks occur downslope in areas where drainage is impeded. The tops of the hummocks are dominated by *Salix arctica* and *Dryas integrifolia* with mosses and other vascular plants occurring on the sides. The areas between the hummocks are usually devoid of vegetation (Figure 3).

Figure 3. Dryas - hummock terrain unit.

Adjacent to the better-drained area is what appears to be an old drainage pathway within which low-centered polygons are evident. The amount of standing water present in July varied between 0-5cm in depth. Carex stans, Pedicularis sudetica and the moss Drepanocladus account for ninety-nine per cent of the vegetative cover in the polygons and on the surrounding rims (Figure 4).

Figure 4. Low-centered polygon terrain unit.

Between the low-centered polygons and the better-drained terrain is a Sedge-hummock community that is transitional between the well and poorly drained terrain units. The vegetation is similar to that in the low-centered polygon community. However, within the polygons small ridges have developed giving rise to an irregular surface topography (Figure 5).

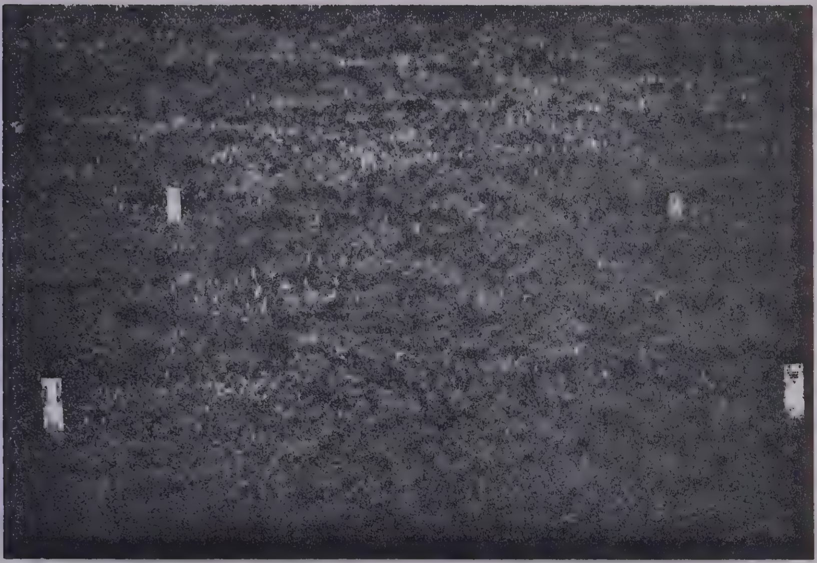

Figure 5. Sedge - hummock terrain unit.

METHODS

Within each of the described terrain unit types three 2X2 metre plots were selected;one was to serve as a control and the other two were to be disturbed. In the first disturbed plot the vegetation and upper portion of the active layer were systematically chopped up with a spade to simulate tracked vehicle activity. In the second disturbed plot everything to the frozen layer was removed to simulate bulldozer blading.

The 2X2 metre quadrats were sampled on the basis of four individual, but contiguous 1X1 metre quadrats. Prior to any manipulations; the presence and per cent cover of all plant species were recorded; the depth of thaw was determined on a 10 cm grid pattern; surface topography was also surveyed

on the same grid in the control plots; soil samples were taken for moisture content analysis and profile description.

Species data for presence and cover of all plots before manipulations are summarized in Tables 1 - IV which also include per cent cover of bare ground or standing water where applicable.

Following manipulation all three plots in each of the four plant communities were probed for depth of thaw on a weekly basis between July 1 and August 12. Metre square plots were established adjacent to all study plots and where indicated were subjected to the same type of manipulation. Such plots were established so that soil cores could be taken every seven days to determine changes in soil moisture.

Soil samples taken for moisture analysis were weighed in the field at time of collection and later oven dried at 104°C for 24 hours. Data on per cent moisture for each soil sample collected are summarized for each plot in Table V.

Statistical data, including the mean, maximum, minimum, variance, standard deviation, standard error and coefficient of variation of the depths of thaw at weekly intervals are summarized for each plot in Table VI.

One important objective of the study was a correlation of vegetation and soil data with the microclimatic data collected by Dr. Smith. Unfortunately the latter phase of the study was not operational until late in the fall. There is every reason to expect that the 1974 field season will result in complete microclimatic data coverage for the wet and dry sites.

PRELIMINARY ANALYSIS AND RESULTS

Vegetation and Soils[1]

Analysis of the vegetation data in Tables 1 and 11 show that the

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[1] Soil profile descriptions for each terrain unit are included in Appendix 1.

TABLE 1

Average percent frequency and cover of plant species*in the Salix - polygon terrain unit.
(12 1 sq.m. quadrats)

	% Frequency	% Cover
Salix arctica	100	12.0
Poa arctica	100	5.5
Stellaria longipes	91	1.2
Dryas integrifolia	83	3.2
Draba sp	58	.5
Papaver radicatum	33	.3
Saxifraga oppositifolia	25	.2
Potentilla rubricaulis	25	.2
Pedicularis arctica	16	.1
Melandrium apetalum ssp arcticum	8	.1
Taraxacum sp	8	.1
Ranunculus nivalis	8	.1
Cerastium alpinum	8	.1
		23.6
Mosses	100	8.0
Litter	100	16.8
Bare ground	100	51.3
	TOTAL AVG.COVER	99.7

* Nomenclature follows Porsild (1964).

Salix - *Dryas* Plain as described by Inglis and Jonkel (1972) can be separated into two clearly distinguishable units within the study area. They are; *Salix*-polygon and *Dryas*-hummock.

On broad, relatively even-surfaced slopes or flats dominated by small, high-centered polygons (Table 1), plant cover is less than twenty-five per cent of the total area. Thirteen vascular plants were found of which only four; *Salix arctica*, *Dryas integrifolia*, *Poa arctica* and *Stellaria longipes* have cover values greater than one per cent. Mosses are restricted in distribution to the more-moist, lower sides of the polygons. Litter, primarily *Salix* leaves, accumulates in the ice wedges where it may act as an insulator to retard thawing.

Bare ground accounts for at least fifty per cent of the total area sampled. The exposed tops of the polygons are generally devoid of vegetation, although *Salix* stems and individual herbaceous species may be present. The exposed soil is a compacted silty loam. The majority of the plants are present on the sides of the polygons where they are less exposed and where they are better able to make use of the available soil moisture.

Even though the impression is of a flat high-centered polygon terrain unit the microtopography is variable. Average polygon height is 20-30 cm and diameter between 1 and 1 1/2 meters.

Soils associated with the *Salix*-polygon unit are undifferentiated. Where vegetation is present a thin organic-mineral layer, up to 4 cm thick, overlies a mineral horizon that varies in thickness from 36-40 cm. Numerous rounded pebbles occur throughout the soil profile. Where vegetation is absent the soil profile is mineral with no indication of any pedogenic processes. Root systems of the woody species extend almost to the perennially frozen layer at a depth of 44cm.

The *Dryas*-hummock unit (Table 11) is not so extensive in areal cover as is the *Salix*-polygon unit. It generally occurs in larger shallow depressions where drainage is impeded. The microtopography is irregular with the small hemispherical hummocks ranging up to 30 cm in height. The same number of vascular plants is present here as in the *Salix*-polygon unit, however, their areal cover is over one hundred per cent greater. *Dryas integrifolia* is the dominant species with a cover value of thirty per cent. *Carex rupestris* and *Salix arctica* have much lower values, nine and seven per cent respectively, and the combined cover of all other species is less than four per cent.

Dryas integrifolia occurs primarily on the tops and sides of the hummocks, while the remaining species are restricted to the sides and occasionally in the moist depressions. Moss cover is low and occurrence is restricted to the depressions. Fruticose (*Stereocaulon* sp) and foliose (*Peltigera*, *Parmelia* and *Physcia* spp) lichens are more abundant in the *Dryas*-hummock unit, although cover is low (9%).

Litter accumulates in the inter-hummock depressions and consists predominantly of *Dryas* and *Salix* leaves. With the increase in per cent cover of the plants the area cover of bare ground is reduced to less than thirty per cent. Evidence of more intensive freeze-thaw action is found in the cracked irregular shapes of the hummocks and the occurrence of stones on the soil surface.

Soils of the *Dryas*-hummock unit are undifferentiated. Active layer thickness is less than that of the *Salix*-polygon unit. Because of the greater plant cover, the organic layer in the soil profile is generally more continuous and thicker (0-5 cm). The mineral horizon varies in thickness from 28-33 cm.

TABLE 11

Average percent frequency and cover of plant species in the Dryas - hummock terrain unit. (12 1 sq.m. quadrats)

	% Frequency	% Cover
Dryas integrifolia	100	29.7
Salix arctica	100	6.8
Carex rupestris	100	8.7
Saxifraga oppositifolia	100	1.1
Festuca brachyphylla	66	1.2
Draba sp	50	.5
Papaver radicatum	25	.2
Stellaria longipes	16	.2
Saxifraga hieracifolia	16	.1
Unknown	16	.1
Potentilla rubricaulis	8	.1
		48.7
Mosses	100	4.1
Lichens	100	7.6
Stereocaulon sp	68	1.1
Peltigera sp	16	.1
Litter	100	18.5
Stones	68	1.3
Bare ground	100	30.3
	TOTAL AVG.COVER	111.7

Low-centered polygons (Table III), in which lateral drainage is restricted, have standing water present for most of the summer. The relatively flat surfaces have an almost complete (91%) moss (*Drepanocladus* sp) cover. Such sites are dominated by a meadow type of vegetation. *Carex stans* is the dominant vascular plant with a cover of twenty-nine per cent. Stems of *Salix arctica* are found scattered throughout the low-centered polygons. The rims of the polygons support the same species as the centers. Total vascular plant cover is approximately thirty-two per cent.

The soil profile of the low-centered polygon unit has no horizon development. A thick, fibrous layer of dead rhizomes, roots and leaf material (5-8 cm thick) overlies a silty-clay mineral layer. The transition between the organic and mineral layer is abrupt. The mineral layer contains an assortment of rounded pebbles suggesting a distant source. Rhizomes and roots extend to the base of the active layer at a depth of 30 cm and are also present in the upper portion of the permafrost.

Because of the transitional nature of the Sedge-hummock unit, species composition contains plants found in both the wet and dry terrain units (Table IV). The overall dominant is again *Carex stans* (19%), although *Alopecurus alpinus* (4%), *Salix arctica* (7%) and *Polygonum viviparum* (8%) are of frequent occurrence. On the low, elevated, but slightly-drier, ridges *Dryas integrifolia* and *Luzula nivalis* are occasionally present. Other herbaceous species more commonly found in the broad surface-run off pathways (Inglis and Jonkel, 1972) are also present. The soil profile is undeveloped. The fibrous organic layer is thinner (3-5 cm) than that associated with the low-centered polygon unit, but is essentially similar in composition. The mineral layer is a silty-clay with rounded pebbles scattered throughout. Rhizomes and roots of the hydrophilic species extend to the base of the active layer and into the perennially frozen ground.

TABLE 111

Average percent frequency and cover of plant
species in the Low-centered polygon terrain unit.
(12 1 sq.m. quadrats)

	% Frequency	% Cover
Carex stans	100	28.7
Salix arctica	75	1.6
Pedicularis sudetica	58	.9
Saxifraga hirculus	16	.1
Cardamine digitata	8	.1
		31.4
Drepanocladus sp	100	90.8
Water	100	8.3
	TOTAL AVG.COVER	130.5

TABLE 1V

Average percent frequency and cover of plant
species in the Sedge-hummock terrain unit.
(12 1 sq.m. quadrats)

	% Frequency	% Cover
Carex stans	100	18.5
Polygonum viviparum	100	8.1
Salix arctica	100	6.8
Alopecurus alpinus	100	4.1
Epilobium sp	75	.7
Saxifraga hirculus	50	.5
Juncus biglumis	41	.4
Dryas integrifolia	41	.3
Ranunculus nivalis	33	.3
Cardamine digitata	33	.3
Pedicularis sudetica	25	.2
Saxifraga hieracifolia	16	.2
Oxyria digyna	8	.1
Luzula nivalis	8	.1
		40.6
Moss	100	92.2
Litter	100	14.8
	TOTAL AVG.COVER	147.6

Vegetation and microtography maps of the plots from which all materials were removed are included in Appendix II. The reestablishment of new individual species in the plots may be compared to the location of similar individuals prior to disturbance.

Soil Moisture

The amount of moisture present in the soil throughout the summer should provide an indication of areal plant cover to be expected. In the plots where the vegetation and thawed soil were removed the amount of moisture in the thawing frozen layer should give some indication of the likelihood of whether or not thermokarst subsidence would be a feature of surface disturbance.

Data pertaining to the soil core samples, together with the calculations of per cent soil moisture, are presented in Table V and Figure 6.

As expected there is a greater per cent of moisture in soils associated with impeded drainage and where plant cover is continuous than better drained, more exposed sites where plant cover is sparse. Moisture conditions in the individual control plots differed considerably during the sampling period. The Low-centered polygon, Sedge-hummock and *Dryas*-hummock active layers all showed an increase in per cent available soil moisture between the first and second sample periods, followed by a decrease over the next fourteen days. The *Salix*-polygon unit however, showed a rapid decrease (reduced by 100%) during the initial period. A reason for this phenomenon might be that the active layer, because of its exposed position begins thawing before the other sites. Only continuous coring from the beginning of the thaw period will show whether or not it follows a similar pattern to the other three units.

TABLE V

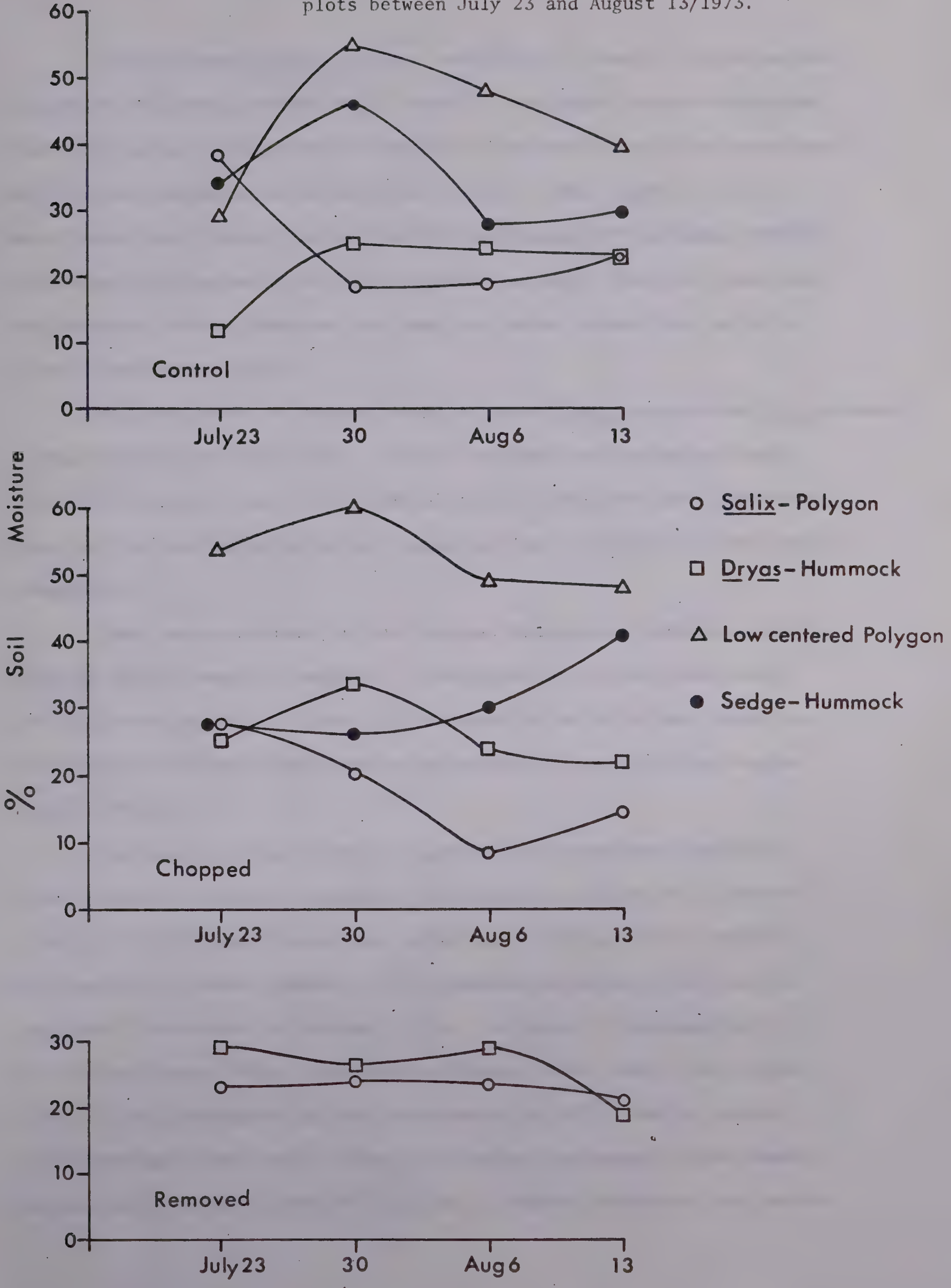
Percent available moisture in soils sampled in control and manipulated plots

	July 23				July 30				August 6				August 13			
CONTROL	Wet wt*	Dry wt*	Mois- ture	%	W	D	M	%	W	D	M	%	W	D	M	%
Site 1	238.9	145.2	93.7	39	119.5	97.0	22.5	19	92.1	74.3	17.8	19	182.9	140.7	42.2	23
2	140.6	99.4	41.2	29	148.8	58.8	90.0	60	169.9	89.3	80.6	47	241.0	144.6	96.4	40
3	182.6	160.1	22.5	12	192.7	145.3	47.4	25	131.0	99.3	31.7	24	131.7	100.4	31.3	23
4	213.4	140.1	73.3	34	154.3	82.6	71.7	46	242.2	177.2	65.0	27	133.1	93.6	39.5	30
CHOPPED																
Site 1	142.0	103.5	38.5	27	104.0	83.0	21.0	20	112.9	102.0	10.9	9	190.8	162.3	28.5	15
2	163.7	75.5	88.2	54	163.2	63.0	100.2	61	175.8	92.1	83.7	48	143.0	74.9	68.1	47
3	146.5	110.3	36.2	25	84.2	55.1	29.1	34	106.9	81.2	25.7	24	144.6	112.8	31.8	22
4	237.2	174.0	63.2	27	258.2	188.9	69.3	26	162.3	113.8	48.5	30	121.7	71.5	50.2	41
REMOVED																
Site 1	149.0	107.8	32.2	23	135.6	103.0	32.6	24	160.6	122.5	38.1	23	208.6	162.4	46.2	22
3	159.3	102.6	46.7	29	149.4	109.7	39.7	26	125.6	90.1	35.5	28	99.3	79.8	19.5	19

* all weights are in grams

Figure 6

Percent available soil moisture in all study plots between July 23 and August 13/1973.



In the chopped plots, moisture conditions followed a similar pattern except for the Sedge-hummock which showed a continuous increase throughout the study period. The initial increases at the end of the first seven days were not as pronounced as in the control plots. This might be due to a more rapid loss of water through evaporation because of increased aeration following the chopping up of the vegetation and soil. Moisture conditions in individual plots throughout the sampling period showed less variation than in the control plots.

Soil could only be removed from two plots (*Salix*-polygon and *Dryas*-hummock) without filling up with water. Per cent available soil moisture varied very little between control and removed plots in these two units indicating both the low precipitation in the region and low ice content in the exposed permafrost.

There was no evidence of even minimal thermokarst subsidence during this the first summer of sampling. Correlation of microclimate data, soil moisture and rate of thaw in 1974 should allow for a more objective assessment of how heavy equipment might effect the soil moisture regime.

Depth of Thaw

Mean depth of thaw values along with other pertinent statistical data at weekly intervals throughout the summer are presented in Table VI. A total of 11,232 data values were collected or 936 values for each of the twelve 2 X 2 meter quadrats. For comparative purposes the data are graphically presented in Figures 7 - 10. In Figure 7, representing the two better drained sites, mean depth of thaw on both control and chopped plots is similar suggesting that disturbance to the insulative surface layer does not effect rate of thaw. Following the removal of the thawed surface layer the mean depth of thaw has a similar increase as the control

TABLE V1

Plot studies, Depth of Thaw (cm).

Salix - Polygon Site 1

	Date	Mean	Max	Min	Variance	Std. Dev.	Std. Err.	Coeff.of Variation
CONTROL								
	July 1	26.5	38	2	47.7	6.9	.64	.26
	July 8	31.7	40	5	57.6	7.6	.69	.24
	July 15	32.2	42	6	38.4	6.2	.57	.19
	July 22	37.3	47	10	39.4	6.3	.58	.17
	July 29	39.1	50	11	38.5	6.2	.57	.16
	Aug. 5	40.8	50	16	44.6	6.6	.61	.16
	Aug. 12	44.8	55	18	31.4	5.6	.51	.12
CHOPPED								
	July 1	24.5	33	1	33.2	6.2	.57	.25
	July 8	30.5	40	2	43.5	6.6	.61	.22
	July 15	32.9	41	3	32.9	5.7	.53	.17
	July 22	36.2	45	5	34.2	5.8	.54	.16
	July 29	37.2	47	6	32.8	5.7	.53	.15
	Aug. 5	40.5	50	10	37.3	6.1	.56	.15
	Aug. 12	43.1	54	12	31.0	5.6	.51	.13
REMOVED								
	July 1	25.2	33	1	62.3	7.9	.73	.31
	July 8	18.3	30	12	6.1	2.5	.23	.13
	July 15	19.6	31	12	4.6	2.2	.20	.11
	July 22	25.2	31	17	7.6	2.8	.25	.11
	July 29	27.4	33	19	8.1	2.8	.26	.10
	Aug. 5	30.7	35	24	4.3	2.1	.19	---
	Aug. 12	33.4	37	27	3.9	2.0	.18	---

Dryas - Hummock Site 3

CONTROL								
	July 1	17.8	30	6	27.4	5.2	.43	.29
	July 8	19.3	32	8	24.0	4.9	.45	.26
	July 15	21.5	33	10	27.9	5.3	.49	.24
	July 22	25.0	36	13	29.2	5.4	.50	.22
	July 29	26.2	38	13	30.9	5.5	.51	.21
	Aug. 5	30.2	44	17	33.8	5.8	.54	.19
	Aug. 12	33.0	46	20	32.2	5.7	.52	.17

TABLE V1 (cont.)

Dryas - Hummock Site 3 (cont.)

CHOPPED

Date	Mean	Max	Min	Variance	Std. Dev.	Std. Err.	Coeff.of Variation
July 1	18.1	30	6	28.6	5.3	.49	.29
July 8	20.2	34	7	29.1	5.3	.50	.27
July 15	20.9	34	10	22.0	4.7	.43	.22
July 22	24.7	35	12	26.2	5.1	.47	.21
July 29	26.2	39	13	24.9	5.0	.46	.19
Aug. 5	30.4	45	19	26.0	5.1	.47	.17
Aug. 12	33.1	48	20	28.9	5.4	.50	.16

REMOVED

July 1	18.8	31	8	29.6	5.4	.50	.29
July 8	16.4	36	10	24.6	5.0	.46	.30
July 15	18.4	25	13	6.0	2.4	.23	.13
July 22	21.8	28	17	7.1	2.6	.24	.12
July 29	22.9	29	17	7.5	2.7	.25	.12
Aug. 5	25.5	31	20	7.7	2.8	.26	.11
Aug. 12	27.0	33	20	8.0	2.8	.26	.10

Low-Centered Polygon Site 2

CONTROL

July 1	19.6	22	16	1.3	1.1	.1	.06
July 8	21.2	25	17	1.8	1.3	.12	.06
July 15	21.4	25	17	1.7	1.3	.12	.06
July 22	23.5	29	20	3.0	1.7	.16	.07
July 29	25.3	30	20	2.9	1.7	.16	.07
Aug. 5	26.8	31	21	3.6	1.9	.18	.07
Aug. 12	28.9	32	24	2.4	1.6	.14	.05

CHOPPED

July 1	21.3	24	20	0.75	0.9	.08	.04
July 8	23.7	26	20	1.5	1.2	.11	.05
July 15	24.0	27	21	1.4	1.2	.11	.05
July 22	26.7	30	25	7.0	2.6	.24	.10
July 29	26.9	30	25	1.7	1.3	.12	.05
Aug. 5	29.9	32	26	1.1	1.0	.09	.03
Aug. 12	31.7	35	28	10.1	3.2	.29	.10

TABLE V1 (cont.)

Low-Centered Polygon Site 2 (cont.)

REMOVED

Date	Mean	Max.	Min.	Variance	Std. Dev.	Std. Err.	Coeff.of Variation
July 1	21.5	28	20	1.2	1.1	.1	.05
July 8	24.5	25	21	.9	.9	.09	.04
July 15	26.8	29	25	1.0	1.0	.09	.04
July 22	36.8	40	27	2.9	1.7	.15	.05
July 29	37.4	40	35	2.3	1.5	.14	.04
Aug. 5	38.9	41	35	2.8	1.7	.15	.04
Aug. 12	44.3	49	41	2.9	1.7	.16	.04

Sedge - Hummock Site 4

CONTROL

Date	Mean	Max.	Min.	Variance	Std. Dev.	Std. Err.	Coeff.of Variation
July 1	29.8	36	21	7.3	2.7	.25	.09
July 8	31.0	38	23	8.4	2.9	.27	.09
July 15	32.4	39	26	7.2	2.7	.25	.08
July 22	33.3	40	27	7.9	2.8	.26	.08
July 29	34.5	41	27	9.1	3.0	.28	.09
Aug. 5	38.3	45	29	9.3	3.0	.28	.08
Aug. 12	40.3	47	33	8.7	2.9	.27	.07

CHOPPED

Date	Mean	Max.	Min.	Variance	Std. Dev.	Std. Err.	Coeff.of Variation
July 1	28.7	35	21	6.9	2.6	.24	.09
July 8	29.3	37	22	8.2	2.9	.26	.10
July 15	29.5	37	23	7.1	2.7	.25	.09
July 22	31.0	37	24	6.3	2.5	.23	.08
July 29	34.0	40	27	6.6	2.6	.24	.08
Aug. 5	37.3	45	30	7.8	2.8	.26	.07
Aug. 12	39.8	47	35	6.5	2.5	.24	.06

REMOVED

Date	Mean	Max.	Min.	Variance	Std. Dev.	Std. Err.	Coeff.of Variation
July 1	30.6	38	24	6.3	2.5	.23	.08
July 8	34.3	39	30	1.6	1.3	.11	.04
July 15	36.3	39	34	1.5	1.2	.11	.03
July 22	48.0	50	44	3.6	1.9	.17	.04
July 29	48.6	51	44	2.9	1.7	.16	.03
Aug. 5	53.3	56	49	4.2	2.0	.19	.04
Aug. 12	58.2	61	51	5.3	2.3	.21	.04

Figure 7

Mean depth of thaw (cm) levels for all plots in the Salix-polygon and Dryas-hummock terrain units between July 1 and August 12/1973.

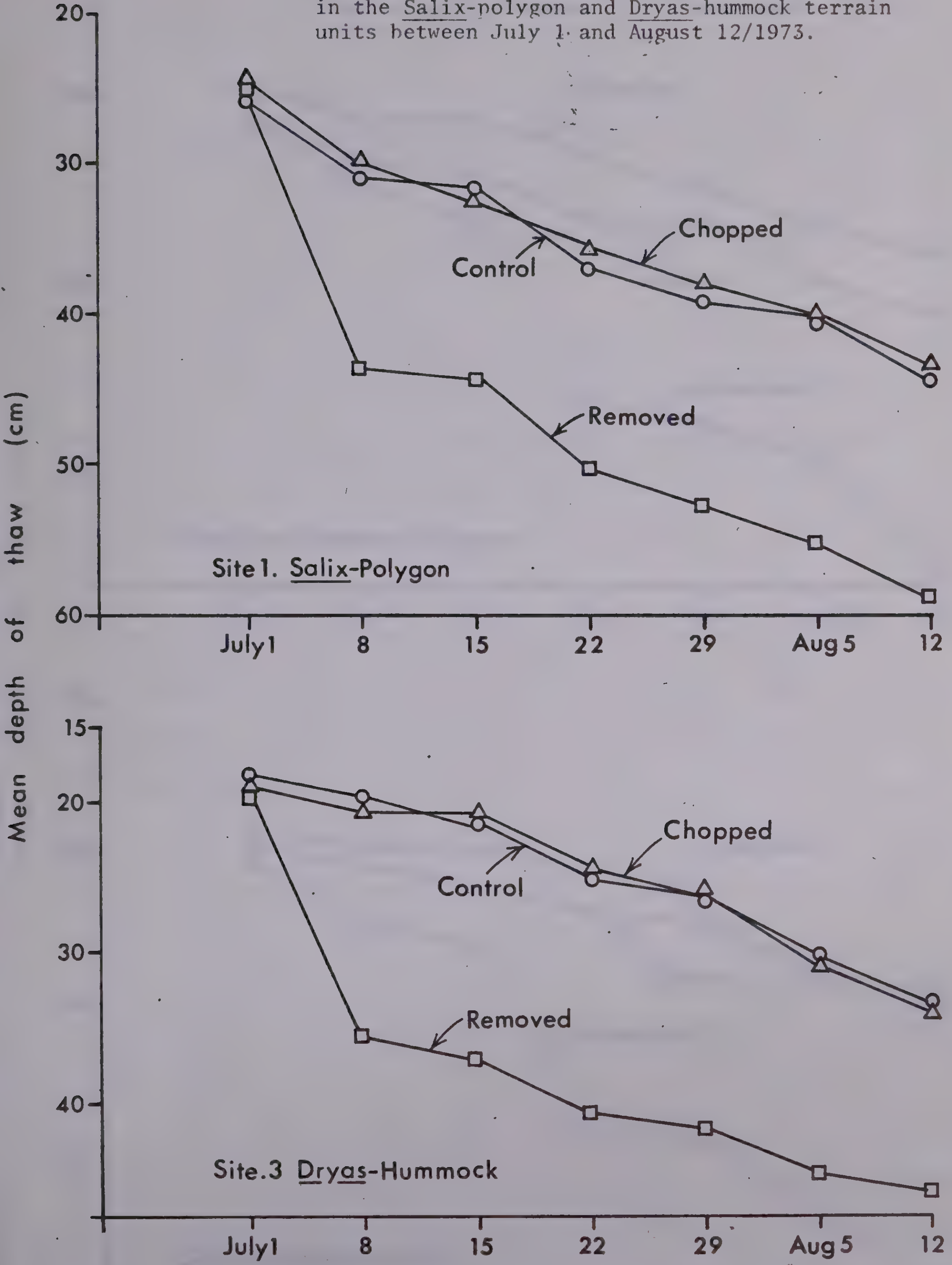
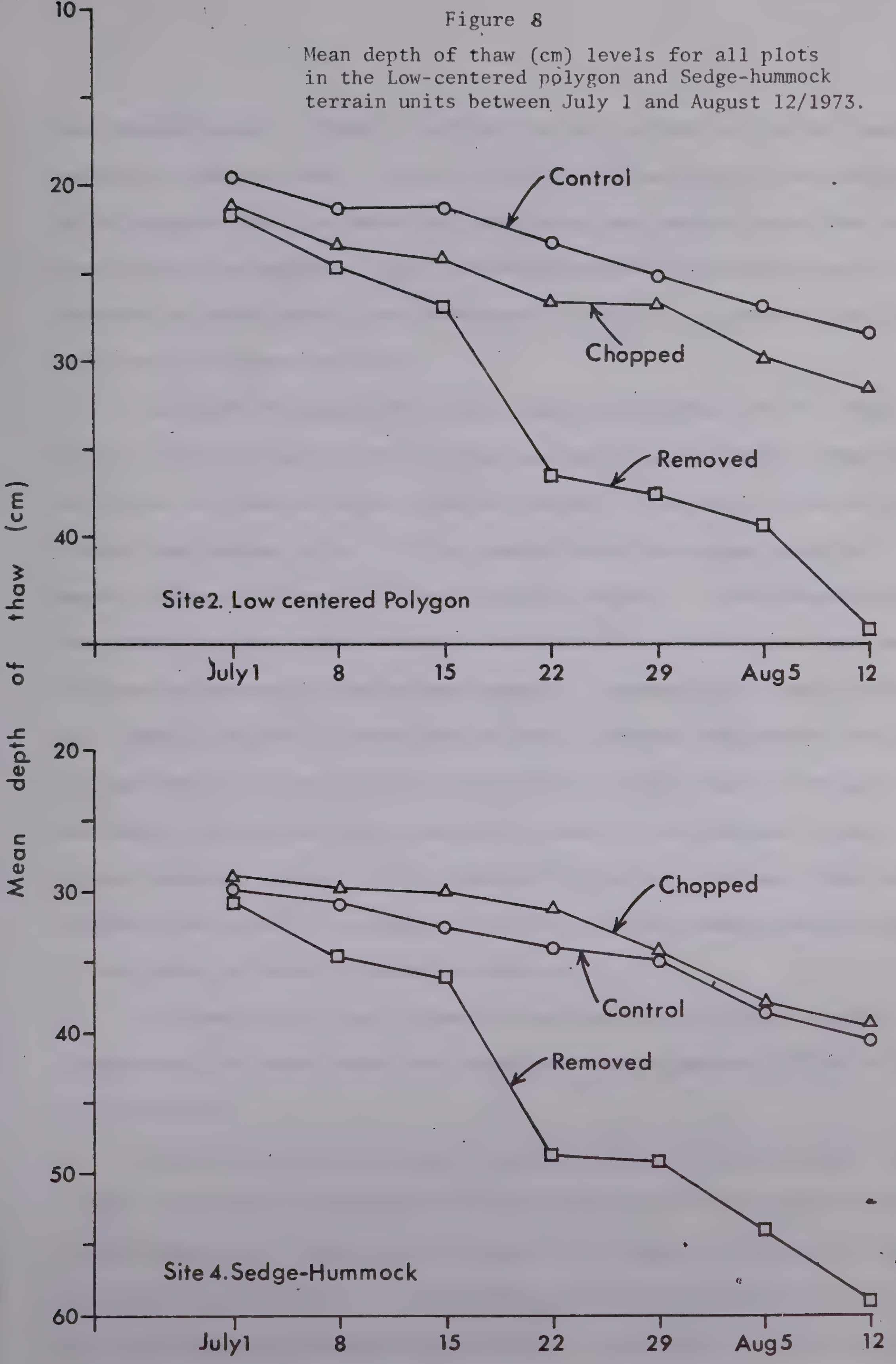


Figure 8

Mean depth of thaw (cm) levels for all plots in the Low-centered polygon and Sedge-hummock terrain units between July 1 and August 12/1973.



and chopped plots. A possible explanation may be found in the soil moisture values for the six plots. There is a minimum of variation in soil moisture which suggests that the permafrost underlying such terrain units does not have a high ice content. While further measurement and observations are required it would appear that thermokarst is unlikely to occur in well drained soils on the Fosheim Peninsula.

In Figure 8, mean depth of thaw values are plotted for the three plots in both the Low-centered polygon and Sedge-hummock units. There is, as in the well drained sites a similar pattern in the rate of thaw of the control and chopped plots. In the removed plots the second and third weeks readings continue to follow a similar pattern. In both cases following the removal of the thawed materials the plots filled with water that seeped in from the surrounding undisturbed terrain. Between July 15 and 22 there was a marked increase in mean depth of thaw. Because temperature data are not available it is not possible to account for this dramatic increase. One might speculate on the presence of a layer of ice that when exposed thawed rapidly. Coring of the permafrost in the two sites and other poorly drained areas would be necessary if one is to be sure that excessive thawing is not going to occur following disturbance.

Soil moisture values between the wet and dry sites differ quite considerably at times during the summer which might account for the differing rates of thaw.

When the mean depth of thaw values for each of the plot types (control, chopped and removed) are plotted (Figures 9 and 10) there are obvious patterns. In the control and chopped plots (Figure 9) the rates of thaw have a trend in a positive direction. In the removed plots (Figure 10) while in a positive direction, the mean rate of thaw is more erratic. This is to be

Figure 9

Mean depth of thaw (cm)levels for all control and chopped plots between July 1 and August 12/1973.

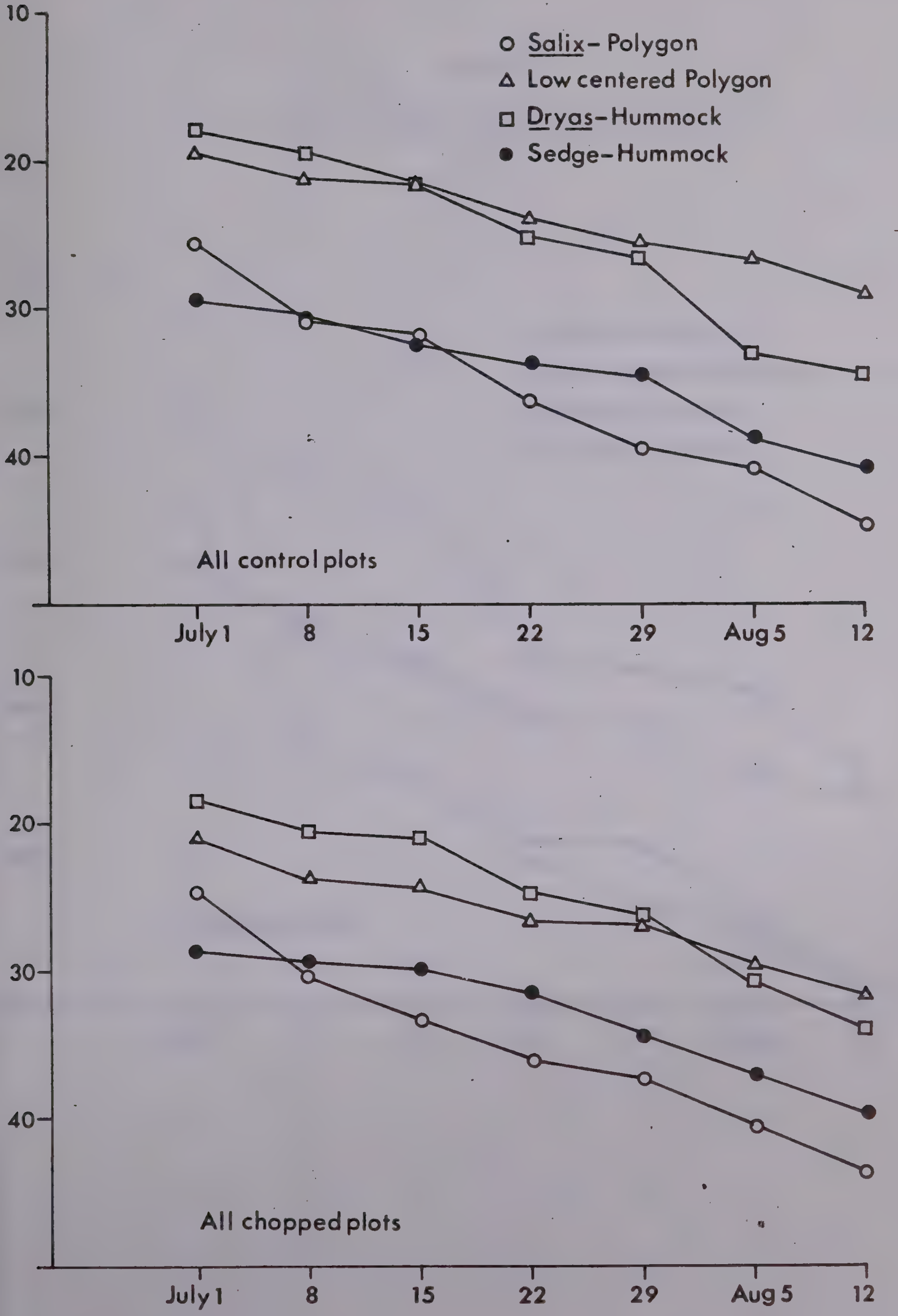
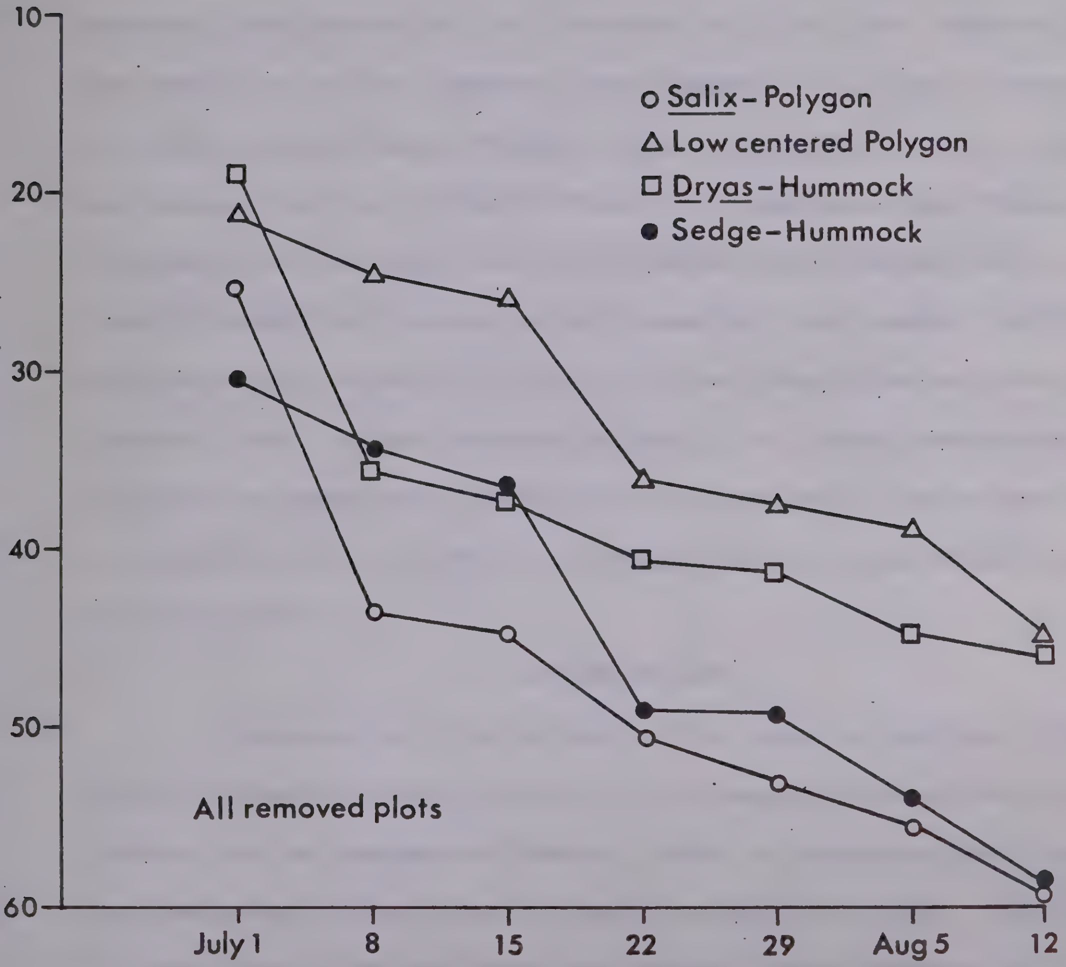


Figure 10

Mean depth of thaw (cm) levels for all removed plots between July 1 and August 12/1973.



expected because the surficial materials were once part of the perennially frozen ground and not subject to annual thawing. Whether or not the mean rate of thaw will follow a similar pattern next summer is open to question.

SUMMARY

Of the investigations to be carried out under the terms of the contract quantitative data are presented on 1) the plant composition and per cent cover of four important plant community types and 2) rates of thaw and soil moisture changes during a seven week period in control, chopped and removed plots in the four communities. Vegetation maps showing surface topography and distribution of plant species are presented for the four plots from which all vegetation and thawed soil was removed. In 1974 additonal data should be available on changes in plant composition and cover in manipulated plots. A more detailed analysis of all plant communities in the area will be undertaken. Providing the microclimate stations are operative on a continual basis correlations between biological and physical parameters will be possible.

RECOMMENDATIONS

If vehicles are to be allowed on the tundra on Northern Ellesmere Island, during the summer period it is recommended that movement be prohibited from wet meadows and creeks. Areas of continuous plant cover are rare and prime grazing areas for musk oxen and arctic hare. Productivity is lower than in the Low Arctic and recovery from disturbance will therefore be slower.

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Appendix 1.

Description of Soil Profiles[1]

Unit	Horizon	Depth from Surface	Boundary	Texture	Structure	Consistancy
Salix - polygon	Ah	0 - 4 cm	irregular	organic	--	loose
	C	0 - 44 cm	permafrost	silt/ loam	--	loose/ friable
Dryas - hummock	Ah	0 - 5 cm	irregular	organic	--	loose
	C	0 - 33 cm	permafrost	silt/ loam	--	loose/ friable
Sedge - hummock	Oh	0 - 5 cm	clear	organic	compact	fibric
	Cg	5 - 30 cm	permafrost	silt/ clay	massive	very stcky plastic
Low - centered polygon	Oh	0 - 8 cm	abrupt	organic	compact	fibric
	Cg	8 - 30 cm	permafrost	silt/ clay	massive	very sticky plastic

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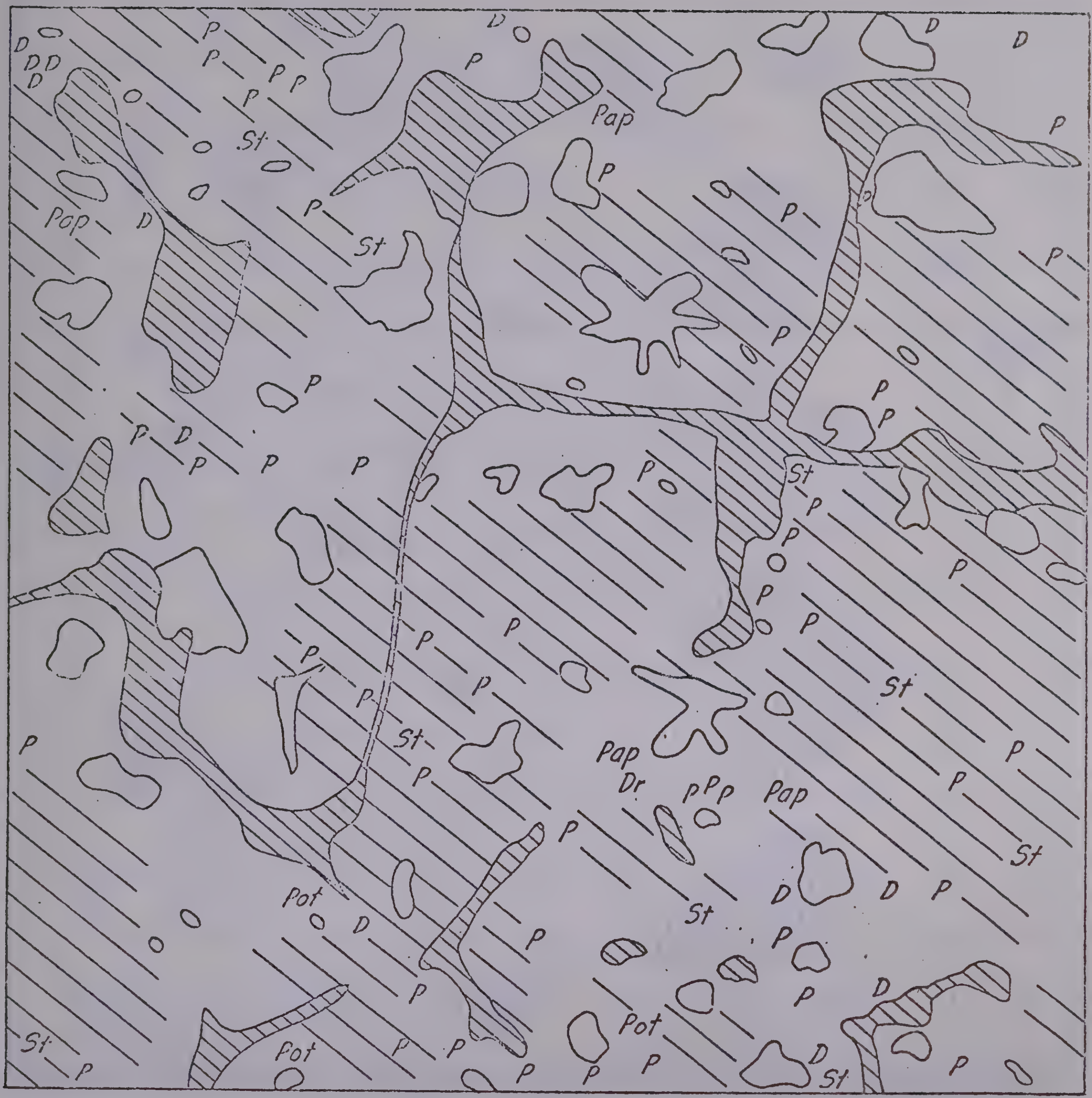
1. Nomenclature from the National Soil Survey Committee of Canada.

Appendix 11

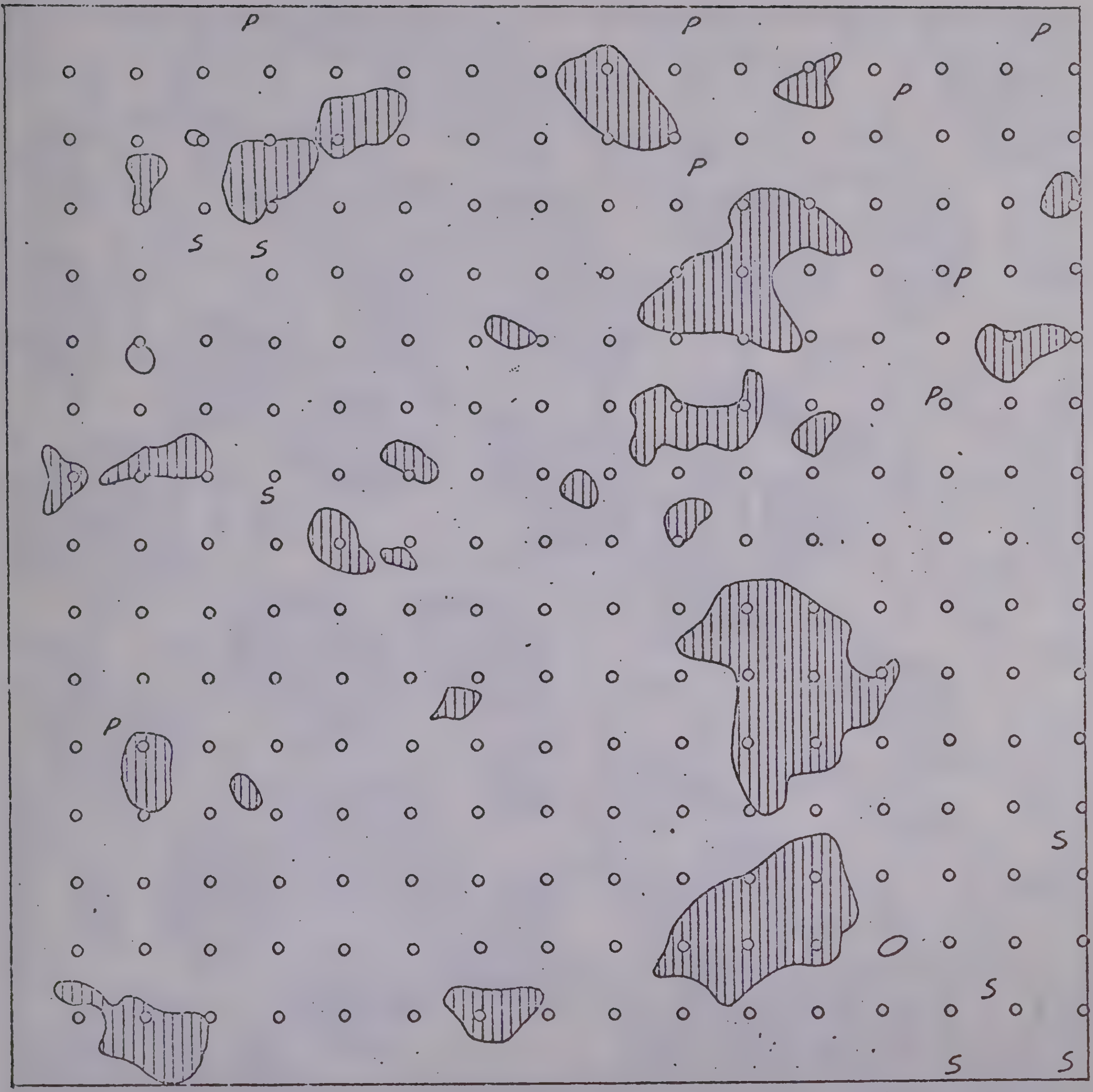
SITE 1



▨	Ice wedges	P	Poa arctica
▧	Bare ground	Pap	Papaver radicatum
⬭	Salix arctica	Pot	Potentilla rubricaulis
D	Dryas integrifolia		
Dr	Draba sp		

Appendix 11 (cont.)

SITE 2



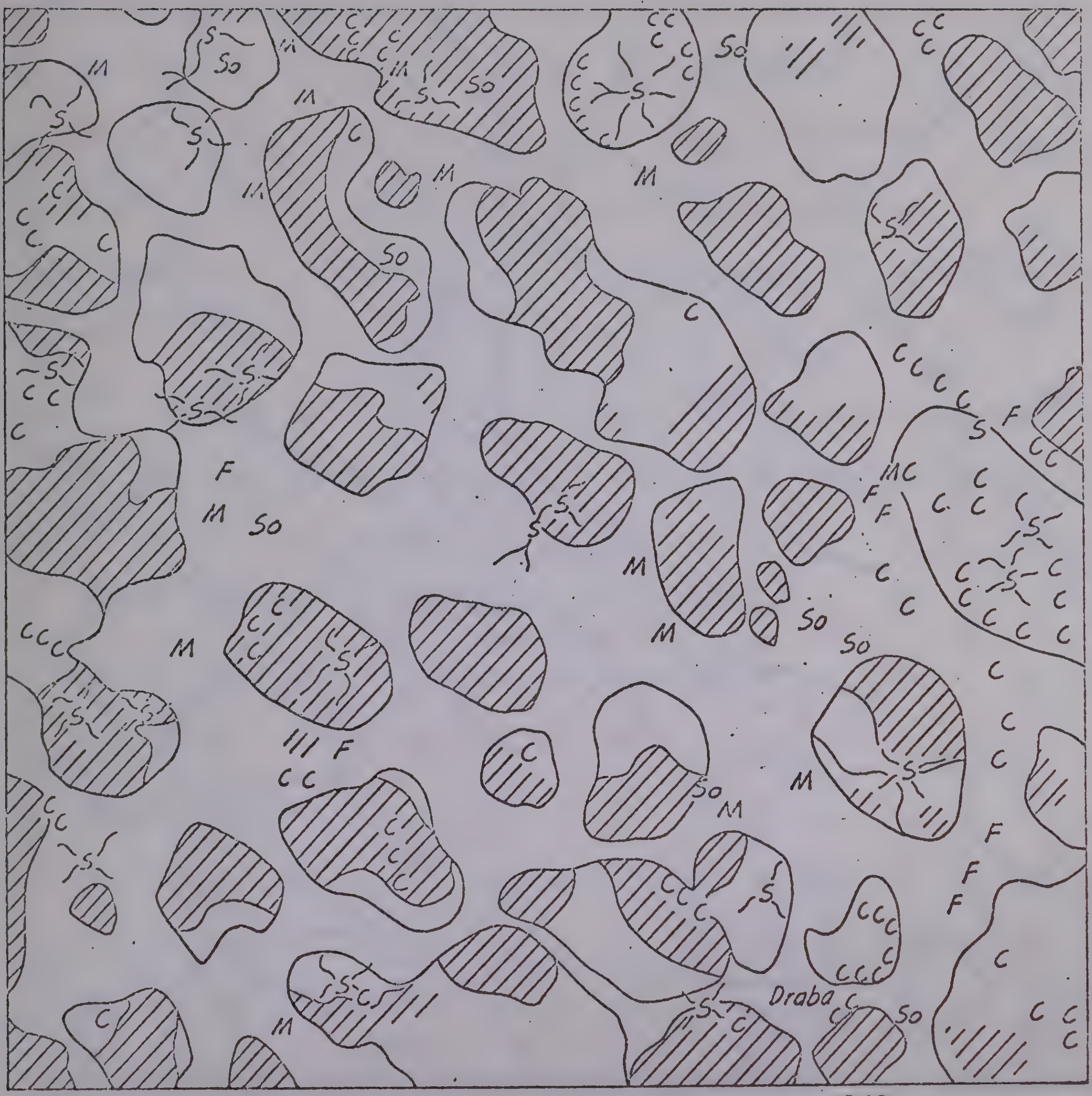
2X2 m. square

O	*Carex stans*	S	*Salix arctica*
P	*Pedicularis sudetica*	▥	Water

Drepanocladus sp throughout plot

Appendix 11 (cont.)

SITE 3

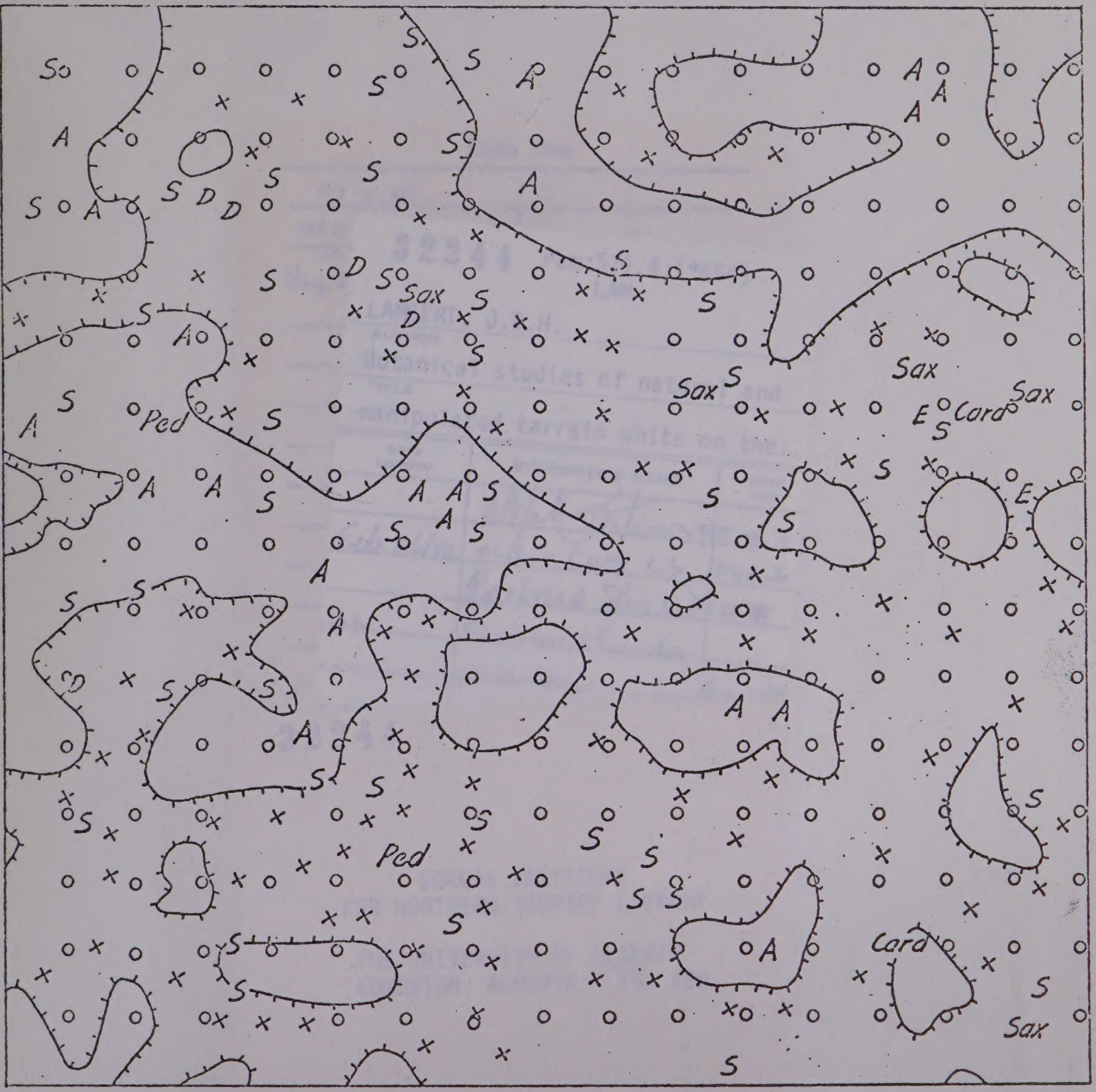


2X2 m. square

▨	Dryas integrifolia	F	Festuca brachyphylla
◯	Hummocks with bare ground	M	Moss
S	Salix arctica	So	Saxifraga oppositifolia
C	Carex rupestris		

Appendix 11 (cont.)

SITE 4



2X2m. square

O	*Carex stans*	P	*Pedicularis sudetica*
X	*Polygonum viviparum*	S	*Salix arctica*
A	*Alopecurus alpinus*	Sax	*Saxifraga hieracifolia*
C	*Cardamine digitata*	⊥⊥⊥	Elevated ground
D	*Dryas integrifolia*		*Drepanocladus* sp throughout plot

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